Cross-Sectional Exposure Assessment of Environmental Contaminants in Churchill County, Nevada

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Centers for Disease Control and Prevention
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EXECUTIVE SUMMARY

Background

As part of its response to the elevated number of children in Churchill County in whom acute lymphocytic leukemia (ALL) had been diagnosed, the Nevada State Health Division (NSHD) requested technical assistance from the Centers for Disease Control and Prevention (CDC). The purpose of the subsequent collaborative investigation was to conduct a cross-sectional exposure assessment to identify contaminants unique to the Churchill County community. We examined exposures to certain chemical contaminants known or suspected to cause cancer in humans, associated previously with clusters of childhood leukemia, thought to be present in the local environment, or because we had the analytic capacity to do so.

Methods

We conducted a cross-sectional exposure assessment that included the families of children already enrolled in an NSHD leukemia investigation and comparison families that we identified through random digit dialing. The study population included 14 ill children who resided in Churchill County before diagnosis of their ALL or acute myelocytic leukemia. Case families included parents and siblings, as well as other care-taking adults in the home. Each case child was matched with four comparison children by sex and age; the matched comparison parents also were enrolled. A total of 205 participants visited a CDC clinic site in Fallon, Nevada. Clinic staff collected extensive questionnaire information and biologic samples (i.e., blood, urine, and cheek swab samples). Environmental samples (i.e., indoor air, play yard soil, household dust, and tap water) were collected from current homes and previous homes for all case families. Environmental samples were also collected from current homes for comparison families and previous homes for one randomly selected matched comparison family for each case family. Biologic and environmental samples were tested for heavy metals, persistent and nonpersistent pesticides, polychlorinated biphenyls (PCBs), and volatile organic compounds (VOCs). We also tested the biologic samples for evidence of previous viral infections. We also tested environmental samples for radon and radionuclides.

Considerable efforts were taken to ensure the quality of the analyses we conducted. We convened statistical and genetic advisory groups to provide external peer review and comment. In addition, a multi-agency panel was formed to review all environmental results using a secure electronic site for data presentation. We also hosted dedicated weekly conference calls to facilitate communication among state and federal partners.

In our cross-sectional analysis, we compared our laboratory results with levels associated with adverse health effects in previous research. When no such levels were available, we compared our results with the geometric mean and 95th percentile levels from the *Second National Report on Human Exposure to Environmental Chemicals (National Exposure Report),* which provides population-based reference ranges. The environmental sample results were compared with published standards that are identified for each chemical.

Appropriate statistical procedures such as cross-sectional descriptive analysis, spatial analysis, and conditional logistic regression assessed the probability that any elevated exposures could have resulted by chance. During our case-comparison analysis, we initially considered the 13 out of 14 case children who had submitted biologic samples. We then repeated the analysis using the nine children who had the most similar disease profiles. The second analysis was limited to case children with precursor-B cell lymphocytic leukemia that was diagnosed before they were 6 years of age, and who lived in Churchill County for at least the 6 months before their diagnosis.

We further compared the infection status of all case children diagnosed with each of the following to their matched comparison controls: precursor-B or B-cell lymphocytic leukemia; precursor-B or B-cell lymphocytic leukemia diagnosed before 6 years of age; precursor-B or B-cell lymphocytic leukemia residing in Churchill County for at least 6 months before the leukemia diagnosis; and T-cell leukemia.

Results

We found community-wide exposure to the element tungsten (geometric mean=1.19 µg/L, 95% CI 0.89-1.59) compared with the *National Exposure Report* reference of 0.08 µg/L (95% CI 0.07-0.09). We also found levels of arsenic in urine samples ranging from nondetectable to 1180.40 µg/L. Normal urine levels of arsenic are lower than 50 µg/L; a level >200 µg/L is considered abnormal and may be associated with health effects. Both tungsten and arsenic were identified in tap water samples community-wide. Six additional metals (antimony, barium, cesium, cobalt, molybdenum and uranium) were either slightly elevated above the population geometric mean or else had more than 10% of their results above the 95th percentile level of the reference population or health-based value. Although individual homes had environmental samples with detectable levels of these metals, they were not elevated community-wide.

Our cross-sectional analysis also identified five nonpersistent pesticides (out of 31 nonpersistent pesticides or metabolites analyzed) that were each above their respective 95th percentile national reference value in more than 10% of the Churchill County urine samples. These pesticides include two organophosphate pesticide metabolites, two chlorinated phenol pesticides, and a fungicide. We also identified an aromatic hydrocarbon pesticide that was slightly higher than the reference. We did not find community-wide elevations of any of these nonpersistent pesticides in environmental samples.

Among 11 persistent pesticides analyzed, we found only DDE (geometric mean=447.07 ng/g of lipid, 95% CI 355.09-562.87) to be above the *National Exposure Report* reference of 260.00 ng/g of lipid (95% CI 234.0-289.0). We did not find elevated levels of DDT or DDE in environmental samples, but levels in humans can reflect historical exposure because these chemicals are stored in body fat. We also found a geometric mean level of 10.46 ng/g of lipid of hexachlorobenzene in our Churchill County study population compared with the national level of less than the detection limit. However, the *National Exposure Report* used an instrument detection limit of 60.5 ng/g of lipid, which is substantially higher than our mean level. We found detectable levels in 18 of the 36 different PCBs that we analyzed; all were below the 95% percentile of the *National Exposure Report*.

VOCs were not included in the *National Exposure Report* so we used population reference levels from the third National Health and Nutrition Examination Survey (1988-1994). We compared arithmetic means and 95% CIs and found no community-wide elevated VOCs. Levels were similar among case and comparison families. VOCs were not elevated in air samples.

In this study, testing for multiple viruses could not definitively relate viral infection to the childhood leukemias in Churchill County.

We used conditional logistic regression to look for a relation between any of the exposures and leukemia status. An odds ratio (OR) greater than 1.00 suggests increased risk, and an OR equal to or less than 1.00 suggests no risk or decreased risk. A p-value less than 0.05 suggests that chance alone is unlikely to explain the deviation from 1.00. Tungsten (OR 0.78, p-value 0.57), arsenic (OR 0.60 p=0.22) and the rest of the metals did not suggest increased risk. One of the PCB congeners had an OR greater than 1.00 (p=0.01), while another congener had an OR less than 1.00 (p=0.02). One VOC (ethylbenzene) suggested increased risk (p-value 0.04) while another (tetrachloroethylene) suggested decreased risk (p=0.004). From the interview information, we identified an increased risk with older paternal age (OR 1.14, p=0.03). We found a decreased risk among children in whom allergic rashes were diagnosed (OR 0.7, p=0.01).

Conclusions and Recommendations

This investigation identified an ongoing environmental exposure of concern among Churchill County residents. We confirmed that many people living in Churchill County still receive significant arsenic exposure, despite the general knowledge that Churchill County water exceeds recommended levels of arsenic in drinking water. We recommend that community members take advantage of alternative water sources until the new water treatment facility is completed.

Biologic results also identified tungsten as a potentially unique exposure within Churchill County. We are working with NSHD to further define tungsten exposure in Nevada and to evaluate potential routes of exposure. Because of our study findings, the National Institutes of Health is considering tungsten as a priority chemical for toxicologic research.

Although biologic results demonstrated a limited degree of elevated pesticide exposure in the community, environmental testing did not identify any sources of ongoing exposure. We recommend conservative use of personal household pesticides and recommend that state public health officials increase public education efforts about safe use of pesticides.

Having found elevated levels of several chemicals, we now plan, with the input of the Children's Oncology Group and other experts, to conduct genetic testing to try to determine whether differences exist between case families and comparison families in genes that are responsible for the way these environmental chemicals are metabolized.

All participants have been given their personal results, as well as information about how to minimize their environmental exposures. We encourage participants to share elevated findings with their personal health care providers.